REVISED

WORK PLAN

GROUND AND SURFACE WATER QUALITY ASSURANCE PLAN, SAMPLING AND PROJECT WORK FOR THE 5-YEAR JOINT HYDROLOGIC STUDY AT KENNECOTT'S UTAH COPPER DIVISION MINE SALT LAKE COUNTY, UTAH

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Date: September 30, 1987

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1.0 INTRODUCTION

This plan presents the quality assurance guidelines and revised work plan for ground and surface water quality sampling being performed at Kennecott's Utah Copper Division Mine in Salt Lake County, Utah. At the request of the Technical Group, this work plan has been upgraded twice since the original May 20, 1985 plan. The original work plan can be found in Report II, Appendix F. The second revised work plan can be found in Report III, Appendix I. This third work plan has been developed by Kennecott and reviewed by Kennecott's consultants, and the Technical Group comprised of Kennecott and the seven state and county technical staff members (Utah State Department of Health and Salt Lake City-County Health Department) working on the five-year ground-water study at Kennecott's Utah Copper Mine. The Advisory Group (comprised of the Kennecott Director of HSEQ, the Director of the Department of Health of the State of Utah and the Director of Environmental Health, Salt Lake City-County Health Department), and EPA Region VIII, aid in study work implementation. The study area encompasses approximately 200 square miles. Initially there were 51 Kennecott monitor wells, 64 private wells and 30 surface water sites being sampled. There are currently 101 Kennecott wells, 111 private wells and 42 surface water sample sites. Round V sampling will include approximately 755 samples for 1987-1988. Fifty-six (56) anew Kennecott wells were added at the completion of Phase I and Phase II drilling. This study was begun in June, 1983. Figure 1 attached shows the approximate study area boundaries and Table 1.0 describes them.

The purposes for this study are to: 1. Evaluate existing and potential adverse impacts to human health and the environment from impacts to groundwater from Kennecott and pre-Kennecott mining operations in the Oquirrh Mining District, and 2. Based on the contaminant point sources and lateral and vertical extent of ground-water contamination, identify potential remedial actions.

In order to define any existing offsite releases to the groundwater, Kennecott completed a Phase I drilling program aimed at filling in data gaps, particularly offsite, in areas likely to be impacted, and on-site, where contaminants are found, but need to be better defined for the preliminary modeling effort.

- The Phase II drilling program completed in August, 1987, was based on the results of the Phase I drilling and sampling and the requirements to complete the contaminant flow model. The Phase II drilling program was more site-specific to the contaminant point sources.

TABLE 1.0

STUDY AREA DESCRIPTION[1]

Township	Range	Sections
2S	1E	7, 18, 19, 30, 31
2S	1W	7-36
2S	2W	7-36
2S	3W	9-16, 21-28, 33-36
3S	1E	6, 7, 18, 19, 30, 31
3S	1W	1-36
3S	2W	1-36
3S	3W	1-4, 9-16, 21-28, 33-36
4S	1E	6, 7, 18, 19
4S	1W	1-24
4S	2W	1-24
4S	3W	1-4, 10-12, 13-15, 22-24

[1] See Figure 1 attached.

2.0 PROJECT DESCRIPTION: OBJECTIVES AND WORK SCOPE

General objectives

The scope of the five year hydrogeologic/hydrologic study was developed by Kennecott and the Technical and Advisory groups and reviewed by Kennecott's environmental consultants, Dames & Moore and Intera Technologies.

The five year study is to accomplish the following:

1. Evaluate the natural resources, the socioeconomic conditions, hydrogeology and hydrology in the vicinity of the Bingham Canyon Mining District.

2. Assess the historic (to determine background, where possible), and existing ground and surface water quality conditions in the vicinity of the Bingham Canyon Mining District, particularly with respect to the impacts from Kennecott's mining operations.

3. Obtain the necessary hydrogeologic and geochemical data required to evaluate the lateral and vertical extent of ground-water contamination.

4. Estimate contaminant movement in the groundwater based on source areas, actual field and laboratory water quality data, water level data, analytical and numerical solutions to ground-water contaminant flow equations and a ground-water contaminant flow model. Contaminant recharge rates can be approximated indirectly from the contaminant flow model.

5. List the potential remedial actions for implementation to solve the ground-water contaminant problems.

General Work Scope

The scope of work required to complete the five year study includes:

1. Review, compilation and summary of available natural resource, socioeconomic, hydrogeologic and hydrologic information in the UCD mine area (draft EAS, October 1984).

2. Continued collection, analysis and evaluation of water samples from existing and new monitor wells, private wells and surface water sample sites (1983-1989), (See Table 2 attached).

3. Drilling, logging, and sampling at new monitor well sites, (beginning in 1985), in strategic hydrogeologic locations, (both lateral and vertical), where definition of hydrogeologic conditions is determined to be critical. Phase I drilling will evaluate potential existing offsite releases; Phase II drilling will evaluate on-site contaminant sources.

4. Collection of geologic and water samples, during new monitor well drilling, at various depths, to evaluate vertical changes in lithology and water quality (1985 - 1987).

5. If needed, completion of a series of column and geochemical tests to evaluate the attenuation characteristics of the subsurface materials (1985-1987) and for completion of a contaminant flow model.

6. Preparation of five annual progress reports and completion of a final environmental impact assessment (1989) to include potential remedial action.

Work Completed To Date

Report 1, June 1984, summarizes published hydrogeologic data pertinent to the study and presented geologic, hydrologic and hydrogeologic data which Kennecott has obtained in the mine area at the Utah Copper Division.

Most of the Round 1 (1983-1984) comprehensive laboratory water quality data results from existing Kennecott monitor wells, surface water sites and private wells (excluding several irrigation wells) and 1982 water quality data were evaluated and are included in Report 1. Any additional Round 1 1984 water quality data, historic water quality data from 1975, natural resource data and socioeconomic information is presented in the October, 1984 draft EAS.

Reports II, and III, and IV include all of the recent water quality data and new (1984 - 1987) monitor well data.

Existing and future ground and surface water conditions will be better defined when the groundwater contaminant flow model is completed.

Specific Project Work Tasks Completed To Date Include

1. A field inventory of Kennecott monitor wells. A total of 51 existing Kennecott monitor wells were sampled, as indicated in Table B-1, Appendix B, Report 1.

2. Unuseable Kennecott monitor wells (19) were grouted to prevent potential deep aquifer contamination (Table B-1, Appendix B, Report 1). Five (5) additional wells were grouted in 1986.

3. A well inventory of private wells in the study area was completed. Well depths and open zones, water level data, well use, well location and well owner information were obtained from the Utah State Engineer's Office and from field investigations and are included in Appendix F, Report 1. Well logs of private wells and Kennecott wells are included in Addendum 1, Report 1.

   Dames and Moore recently (August, 1987) completed an extensive survey of wells and water quality data from sources other than the Utah State Engineer's Office. This data will be used in calibrating the groundwater contaminant flow model.

4. A total of one hundred one (101) Kennecott monitor wells have been sampled, tested in the field for conductivity, temperature, pH, carbonate and bicarbonate, and analyzed for a comprehensive number of constituents in Kennecott's laboratory.

5. A total of forty two (42) springs and streams and five (5) Kennecott facilities have been sampled for comprehensive laboratory analyses and field tested for conductivity, temperature, pH, carbonate and bicarbonate.

6. One hundred-eleven (111) representative private water wells which can be sampled are included in Kennecott's sampling program.

7. Laboratory analyses have been extensive and included analyses of 45 constituents at all sample sites and 57 constituents (which also included organics and radionuclides) at a few selected sample sites. Total as well as dissolved metals concentrations have been analyzed.

   The field and laboratory sampling and analyses collected since 1975 and the 5-year study have been conducted according to EPA recommended procedures. The results of the laboratory analyses and the field information for Rounds 1, 2, 3, and 4 water quality sample site sheets are included in Reports I, II, III, and IV.

   The more detailed borehole geophysical logs, and borehole geologic logs and well construction data are included in the Reports I, II, III, and IV. All available historic geologic logs are available at Kennecott's environmental office.

   The work conducted for the draft EAS completion (October, 1984) included:

   1. Evaluation of all Round 1 water quality sample results.

   2. Evaluation of all historic water quality data back to 1975.

   3. Preliminary socioeconomic, natural resource and water use evaluations.

8. Rounds 2, 3, and 4 water quality sampling and analyses and Phases I and II drilling have been completed with data evaluation ongoing for Report V and the final EIA completion in 1988.

9. Seven resistivity surveys were conducted near locations of new Phase II well sites to choose locations for the Phase II wells in zones of pin point higher permeable, permeability.

10. Phase I monitor well drilling to better define on-site and off-site sub-surface conditions in both lateral and vertical directions (1985 - mid-1987). Completed.

11. Phase II monitor well drilling to better define primarily on-site contaminant source areas and plume movement in both lateral and vertical directions (1986 - mid-1987). Completed. One upgradient and two downgradient wells will be completed at source areas, where feasible. Only where extremely complex sub-surface conditions prevail will additional wells be drilled.

Future Project Work Tasks And Estimated Completion Times

- Aquifer pumping tests, where needed, to define transmissivities, permeabilities, storage coefficients, the confining bed(s)' integrity to restrict inter-aquifer flows, at existing and/or new well sites, in critical areas of contamination. Such tests, if conducted, would be part of the remedial action phase.

- Ongoing refinement of geologic cross-sections as new sub-surface geologic data are obtained (Annual Reports 3, 4, 5 and the final EIA in 1986, 1987 and 1988).

- If required at key monitor well sites near contaminant source areas, horizontal and vertical laboratory permeabilities at 10 foot intervals in the unsaturated zones and within each distinct saturated stratigraphic zone (1986 - mid-1987). Such tests, if conducted, would be part of the remedial action phase.

- Specific capacity tests will be conducted in monitor wells during the 1987-1988 sampling period.

- Continued annual and selected quarterly water quality sampling and water level monitoring at existing and new monitor well sites. Monthly sampling of selected private wells will continue in the area of the new evaporation ponds.

- Upgrading of water level data for the groundwater flow model calibration, to refine ground-water flow rates and directions, in both the shallow and deep aquifers.

- Where and if necessary to define sub-surface contaminant movement, for remedial action purposes, soil infiltration and soil contaminant retardation studies may be conducted.

- The final EIA will identify (1) aquifer and confining unit geometries; (2) ground-water quality, movement, occurrence and productivity; (3) ground-water flow controls and recharge/discharge areas; (4) recharge/discharge rates, where possible; (5) confining units' integrities; (6) ground-water contaminant flow rates and directions via actual data and use of the ground-water contaminant flow model (1989).

- Contaminant migration mechanisms that may be considered by Dames and Moore for the model are: surface water to ground-water contaminant movement; losing and gaining surface water delineation; where appropriate, soil properties to evaluate infiltration and retardation of contaminants; unsaturated zone properties needed to estimate contaminant transport; soil chemistry properties, where needed, to estimate contaminant movement through soils (1985-1987).

- Contaminant properties that need to be defined are: (1) a list of contaminants, (2) the physical and chemical properties of the contaminants, (3) estimates of the quantities of individual contaminants available for release, (4) mobility, persistence and effects of individual contaminants, (5) potential modes of individual contaminant releases, and (6) estimates of contaminant movement from existing contaminant source areas.

The work scope and rationale for the Phase I and II drilling programs is presented herein. The purpose of this five-year study is to evaluate Kennecott's potential impact to human health and the environment. Kennecott is concerned that there is existing offsite ground-water contamination. The Phase I drilling program was designed to evaluate the ground-water quality in areas that may already be impacted, but where there are currently no wells to monitor. Phase II drilling will focus[ed] in on site specific contaminant sources, upgradient and downgradient. Detailed specifications for Phase II drilling is completed based on the data from Phase I well drilling and sampling data that have been evaluated in conjunction with the existing monitor well site data. March, 1985 and July, 1986 technical recommendations from EPA Region VIII, the Utah Department of Health, the Utah Geologic and Mineral Survey, the Utah Division of Oil, Gas and Mining and the Utah Water Research Laboratory at U.S.U. were included in the Phase II drilling program.

TECHNICAL BASIS FOR PHASE I MONITOR WELL LOCATIONS AND DEPTHS

(This is the original basis for Phase I monitor well specifications, May 20, 1985. The final well construction specifications are listed in Table 1B).

I. Well Depths Rational

The estimated well depths for all of these sites were rough estimates based on ground surface elevation, estimated depths to the first water table (see Figure 18 from Report 1 attached) and estimated thicknesses of low permeability zones (i.e. confining units) separating the upper shallow water table from the deeper aquifer.

Where shallow, intermediate and/or deep wells were scheduled to be drilled, the deepest well was drilled first, cuttings logged and geophysically logged in some cases to evaluate (1) depth to first water and depth of the shallowest well (2) low permeability "confining" zones and (3) deeper high permeability transmissive zones along which deeper major ground-water flows might be encountered (i.e. the lower aquifer or at least the lower most permeable zones beneath the first saturated zone). The purpose in so doing is to complete monitor wells in the shallow aquifer and deeper aquifer.

Attached is Table 1A with the Phase I estimations for well designations, ground elevations, estimated depth to water elevations and estimated drilling depths.

II. Well Locations

As presented and agreed to at the February 19, 1985 Technical Group Meeting, the basis for the final well locations as shown on the attached Figure 2 are as follows:

- Sites 1(S,I,D), 2(S), 3(S) and 4(S) are located approximately .5 to 1 mile east of the leach dumps to better define the subsurface geology and to better define the contaminant plume along the leach dumps. Sites 1(S,I,D) and 2(S) are upgradient of the Lark tailings.

- Site 5(S,I,D) is upgradient of the 500 million gallon reservoir, along the Bingham Creek channel.

- Sites 6(S) and 7(S,I) are north and east of the 500 million gallon reservoir, offsite, to define the subsurface geology and to fill in the water quality data gaps which exist due to the fact that the existing Kennecott monitor wells in this area are no longer sampleable (i.e. wells have caved in or were destroyed).

  These two sites were relocated by the Technical Group, as shown at the February 19, 1985 Technical Group meeting.

- Sites 8(S,I), 9(S), 10(S,I), 11(S,D) are as located, to fill in gaps in the subsurface geologic data and ground-water quality data which exist offsite which may show some contamination from historic discharges along Bingham Creek and from historic untreated discharges to the old unlined evaporation ponds.

- Site 12(S,D) wells were completed in 1984 to evaluate the shallow and deep contamination near wells P198 and P199. Well P198 had shown contamination in 1983-1984. Well P198 is a deep well (510-520' open), but evidently is receiving shallow contamination from the upper aquifer. Well 12D = P240B (280-360' open), did not indicate contamination at depth and well 12S = P240A (100-150' open) did show contamination.

  <u>Note</u>: Well P240B was not completed at (510-520') as at P198 and as agreed to by the Technical Group, because although P240B was drilled to 530', the entire interval from 360 to 530' was silt and clay. The contamination in P198 is therefore from surface contamination along the sides of the casing. Well P198 should therefore be considered for grouting and abandonment.

- Site 13(S,D) is located near Mr. Wells and Mr. Ham's wells, which showed contamination in late 1984-1985. Water quality data from these two new wells will determine if the contamination at the Wells and Ham sites is due to vertical seepage along their well casings or lateral contaminant plume movement from the evaporation ponds.

- Site 14(S,D) is located along an old delta between the old and new evaporation ponds to monitor shallow and deep water quality in this area where a data gap exists.

- Site 15(S,I) is located at well site P202C to determine if the deep contamination at P202C (560-600' open) is real or is occurring due to vertical seepage along the casing. Well 15I = P241B was completed in 1984 but not yet sampled. P241B was drilled to 595' but open from 530-570' in the permeable zone.

- Site 17(S), as recommended by the Technical Group, is located to monitor the groundwater between the new evaporation ponds and the homes along 11,800 South where basement flooding occurred in 1984.

- Site 16(S,I) is located between the new lined evaporation ponds and Riverton City's wells, to monitor any potential impacts to their wells from the new evaporation ponds. Although Riverton City's wells are not located downgradient from the ponds, Kennecott has agreed to locate a monitor well at this site.

TECHNICAL BASIS FOR PHASE II MONITOR WELL LOCATIONS AND DEPTHS

I. Well Depths

The well depths for all of these sites [were] are rough estimates based on ground surface elevation and estimated depths to the first water table.

Where shallow, intermediate and/or deep wells were scheduled to be drilled, the deepest well was drilled first, cuttings logged and geophysically logged (only where mud rotary is used) to evaluate (1) depth to first water and depth of the shallowest well (2) low permeability "confining" zones and (3) deeper high permeability transmissive zones along which deeper major ground-water flows could be encountered (i.e. the lower aquifer or at least the lower most permeable zones beneath the first saturated zone). The purpose in so doing was to complete monitor wells in the shallow aquifer and deeper aquifer zones.

Attached is Table 1B with the Phase II designations and estimated depths and screened intervals, and the final Table 1C, with final well completions for both Phases I and II wells.

II. Well Locations

As presented and agreed to at the August 21, 1986 Technical Group Meeting, the basis for the Phase II well locations as shown on the attached Figure 2 are as follows:

- P258 A,B — located along 1300 West, 9900 South in the vicinity of the W 300 wells which show poor quality groundwater, the shallow well to monitor the poor quality artesian flows, the deeper well to monitor the better quality zone.
- P259 — located along 10200 South, 3200 West to evaluate the water quality near the USGS well at about 3600 West and near private well W-11, both of which have shown poor quality.
- P260 — located along 4000 West 9400 South along Bingham Creek to better define the water quality along Bingham Creek in this area.
- P261 — located northeast of the old evaporation ponds along 4000 West to determine if a contaminant plume exists in this area.
- P262 — located along 11400 South near 3600 West to evaluate if there is groundwater contamination from evaporation pond seepage in this area.

- o P263 — located just east and towards the south of the new evaporation ponds, to evaluate the potential for or existence of groundwater contamination from evaporation pond seepage in this area.

- o P264 — located along Highway 111 between the Bingham Reservoir and the depression where P241B is located to evaluate the hydrogeology and groundwater quality in this area.

- o P265 — located along 4800 West, 12600 South near the Butterfield Creek drainage to evaluate the hydrogeology and groundwater quality.

- o P266 — located along 6000 West, 11900 South, along Midas Creek drainage, to better define the hydrogeology in this area.

- o P267 A,B — located just west of Herriman, along Highway III, to define the water quality at depth, near Herriman, in an area where groundwater useage has and will continue to develop.

- o P268 — located along 11800 South, down gradient from the Lark tailings to evaluate downgradient groundwater quality.

- o P269 — located in the center of the Lark tailings to define the underlying groundwater quality.

- o P270 — located along the Butterfield Creek drainage, about 1 mile east of the mouth of Butterfield Canyon.

- o P271 — located just upgradient of the Lark Tailings area.

- o P272 — located in the southwest corner near the dumps, above Keystone Gulch, as a replacement for P239 (which is down in the draw and contaminated by surface runoff waters from the dumps.

- o P273 — located west and adjacent to the sludge disposal facility to evaluate the hydrogeology and the groundwater quality west of the sludge disposal facility where poor quality water was intercepted.

- o P274 — located east of the northern active dumps to evaluate the groundwater quality just east of the leach collection system.

- P275 — located in Barney's Wash, north and east of P242 to better define the water quality north and east of Phase I well P242.

- P276 — located along the Bingham Canyon Highway, around 9200 South and 6400 West, to better define the water quality north and east of Phase I well P249A

- P277 — located along Bingham Creek, to be drilled to a depth of around 1000 feet to evaluate both the lateral and vertical extent of contamination along Bingham Creek. Exact location was recommended by Cal Clyde (Utah State University) and Dames and Moore.

TABLE 1A ESTIMATED WELL DEPTHS
(Phase I Wells)

Well Designation	Geologic** Units	Estimated*** Well Depth (in ft)	Anticipated*** Screen Interval (in ft)	Approx. Ground Elevation -	Approx. Water Level Elevation =	Approx. Depth To Water
1S	Tv	160	120 - 160	5640 -	5500	= 140
1I	Tv	300	260 - 300	-		-
1D	Tv	360	340 - 360	-		-
2S	Tal, Tv	120	80 - 120	5500 -	5400	= 100
3S	Tv	120	80 - 120	5500 -	5400	= 100
4S	Tal, Tv?	220	180 - 220	5500 -	5300	= 200
5S	Tal, Tv?	220	180 - 220	5400 -	5200	= 200
5I	Tal, Tv?	300	260 - 300	-		-
5D	Tal, Tv?	350	310 - 350	-		-
*6S	Tal, Tv?	130	90 - 130	5360 -	5250	= 110
*7S	Qal, Tal?	330	290 - 330	5160 -	4850	= 310
*7I	Qal, Tal?	350	320 - 350	-		-
*8S	Qal	220	180 - 220	4880 -	4675	= 205
*8I	Qal	300	260 - 300	-		-
9S	Qal	160	120 - 160	4450 -	4310	= 140
10S	Qal	300	260 - 300	4520 -	4240	= 280
10I	Qal	350	320 - 350	-		-
11S	Qal	300	260 - 300	4510 -	4230	= 280
11D	Qal	350	310 - 350	-		-
*13S	Qal	50	25 - 50	4625 -	4600	= 25
*13D	Qal	300	260 - 300	-		-
14S	Qal	150	110 - 150	4780 -	4650	= 130
14D	Qal	300	260 - 300	-		-
15S	Qal	350	320 - 350	5100 -	4800	= 300
16S	Qal	200	160 - 200	4650 -	4470	= 180
16I	Qal	300	260 - 300	-		-
17S	Qal	125	185 - 125	4650 -	4550	= 100

Total Footage = 6715 ft.

* Relocated by the Technical Group.
** Geologic Units
Qal - Quaternary alluvial and sediments of Lake Bonneville
Tal - Tertiary alluvial sediments
Tv - Tertiary volcanic rocks (may include some intrusive igneous rocks)
*** Final depths will not be specified until borings have been geophysically logged.

TABLE 1B

ESTIMATED WELL DEPTHS*

Well Designation	Geologic Units**	Estimated*** Well Depth (in feet)	(Phase II Wells) Anticipated Screen Interval (in feet)
P258A	Qal	160	140 - 160
P258B	Qal	240	220 - 240
P259	Qal, Tal?	240	220 - 240
P260	Qal	195	175 - 195
P261	Qal	130	110 - 130
P262	Qal	110	90 - 110
P263	Qal	140	120 - 140
P264	Qal	150	130 - 150
P265	Qal	165	145 - 165
P266	Qal	235	215 - 235
P267A	Qal	240	220 - 240
P267B	Qal, Tal?	300	280 - 300
P268	Tal	210	190 - 210
P269	Tal	170	150 - 170
P270	Qal	120	100 - 120
P271	Tal	140	120 - 140
P272	Tv	110	140 - 160
P273	Tal	340	320 - 340
P274	Tal	210	190 - 210
P275	Tal, Tv?	330	310 - 330
P276	Qal, Tal?	280	260 - 280
P277	Qal, Tal, Tv?	1000	?

* See Disclaimer (Section 4.2.2.6.4)

** Geologic Units

Qal - Quaternary alluvial and sediments of Lake Bonneville

Tal - Tertiary alluvial sediments

Tv - Tertiary volcanic rocks (may include some intrusive igneous rocks)

*** Final depths will not be specified by Engineer during course of drilling based upon subsurface conditions encountered.

TABLE 1C

WELL COMPLETION SUMMARY FOR PHASES I AND II WELLS

Phase I Well Desig- nation	Well Desig- nation	Completion Date	Hole Depth (ft)	Screened From (ft)	Screened To (ft)	Sand Pack Interval From (ft)	Sand Pack Interval To (ft)	Lithology Of Screened Interval
	P239	09-24-84	110.0	90.0 -	100.0	70.0 -	110.0	Volcanics
	P240A	10-04-84	200.0	100.0 -	150.0	100.0 -	155.0	Clay, gravels
	P240B	10- -84	530.0	320.0 -	330.0	280.0 -	360.0	Clay, silt, gravels
15S	P241A	05-17-86	330.5	310.0 -	330.0	303.5 -	330.5	Sand, gravel
	P241B	11-27-84	600.0	530.0 -	570.0	520.0 -	570.0	Sand, gravel, silt
	P241C	07-14-86	440.0	385.0 -	405.0	378.0 -	410.0	Gravel, sand, silt
6S	P242	09-14-85	196.0	170.0 -	190.0	162.0 -	196.0	Gravel, sand
2S	P243	09-17-85	87.0	65.0 -	85.0	60.0 -	87.0	Volcanics
1S	P244A	09-23-85	57.0	45.0 -	55.0	39.0 -	57.0	Gravel, volcanics
1I	P244B	09-20-85	82.0	70.0 -	80.0	64.0 -	82.0	Volcanics
1D	P244C	09-26-85	134.0	113.5 -	133.5	106.0 -	134.0	Volcanics
3S	P245	09-16-85	140.5	120.0 -	140.0	113.0 -	140.5	Volcanics
4S	P246	10-14-85	260.0	205.0 -	225.0	196.0 -	230.5	Sand, volcanics
13S	P247A	02-22-86	230.0	209.0 -	229.0	202.0 -	230.0	Sand, gravel
13I	P247B	05-13-86	905.0	615.0 -	665.0	532.0 -	665.0	Gravel, silt, clay
5S	P248A	03-17-86	100.0	80.0 -	100.0	73.4 -	100.0	Gravel, sand
5I	P248B	01-02-86	140.5	120.0 -	140.0	113.0 -	140.5	Volcanics
5D	P248C	12-21-85	200.5	175.0 -	195.0	168.5 -	198.0	Volcanics
7S	P249A	02-16-86	328.8	308.0 -	328.0	301.0 -	328.8	Silt, sand, gravel
7I	P249B	04-18-86	400.0	370.0 -	390.0	363.0 -	400.0	Gravel, sand
8S	P250A	05-04-87	320.0	300.0 -	320.0	293.0 -	320.0	Gravel
8D	P250B	03-12-87	431.0	411.0 -	431.0	373.0 -	400.0	Clay, sand
9S	P251	04-04-86	145.0	120.0 -	140.0	116.2 -	145.0	Gravel, silt
10S	P252A	08-07-86	155.5	135.0 -	155.0	129.3 -	155.5	Gravel, sand
10I	P252B	09-12-86	255.5	235.0 -	255.0	226.1 -	255.5	Gravel, sand
10D	P252C	07-31-86	400.0	360.0 -	380.0	353.0 -	385.0	Sand
11S	P253A	06-06-86	135.0	115.0 -	135.0	108.0 -	135.0	Sand, gravel, silt
11I	P253B	05-28-86	390.0	365.0 -	385.0	345.4 -	390.0	Gravel, silt, sand
14S	P254A	04-01-86	217.0	197.0 -	217.0	185.5 -	217.0	Sand, gravel, clay
14I	P254B	01-29-86	387.0	335.0 -	355.0	323.2 -	365.0	Clay, gravel, sand
16S	P255A	06-24-86	60.0	40.0 -	60.0	34.9 -	60.0	Sand, gravel, silt
16I	P255B	06-24-86	160.0	125.0 -	145.0	118.0 -	160.0	Gravel, silt, sand

TABLE 1C (Continued-2)

Phase I Well Designation	Well Designation	Completion Date	Hole Depth (ft)	Screened From (ft)		Screened To (ft)	Sand Pack Interval From (ft)		Sand Pack Interval To (ft)	Screened Interval
17S	P256	04-08-86	287.0	240.0	-	260.0	227.0	-	287.0	Gravel, sand
	P257	07-31-86	115.0	70.0	-	90.0	65.0	-	95.0	Gravel, silt, sand
	P258A	12-17-86	90.5	67.0	-	87.0	63.0	-	90.5	Gravel, sand
	P258B	12-09-86	235.0	214.5	-	234.5	209.0	-	235.0	Sand, gravel, clay
	P259	*	175.0	154.5	-	174.5	148.0	-	175.0	Sand, gravel
	P260	*	115.0	94.5	-	114.5	89.0	-	115.0	Gravel, sand
	P261	10-21-85	120.0	100.0	-	120.0	95.0	-	120.0	Silt, sand
	P262	01-03-87	197.0	176.5	-	196.5	170.5	-	197.0	Gravel, sand, silt
	P263	02-02-87	325.0	230.0	-	250.0	225.0	-	260.0	Gravel, sand
	P264	08-16-87	505.0	485.0	-	505.0	478.0	-	505.0	Gravel, sand
	P265	03-19-87	142.0	122.0	-	142.0	117.0	-	142.0	Sand, gravel
	P266	11-19-86	235.0	215.0	-	235.0	209.0	-	235.0	Gravel
	P267A	02-28-87	165.0	145.0	-	165.0	140.0	-	165.0	Gravel, sand
	P267B	02-11-87	340.0	320.0	-	340.0	313.0	-	340.0	Gravel, silt
	P268	11-03-86	240.0	220.0	-	240.0	213.0	-	240.0	Gravel, silt
	P269	10-23-86	155.0	135.0	-	155.0	129.9	-	155.0	Gravel, sand
	P270	04-06-87	199.0	179.0	-	199.0	169.0	-	199.0	Volcanics
	P271	10-14-86	85.0	65.0	-	85.0	85.5	-	85.0	Volcanics
	P272	10-10-86	105.0	85.0	-	105.0	79.7	-	105.0	Volcanics
	P273	07-17-87	340.0	320.0	-	340.0	313.0	-	340.0	Sand, gravel
	P274	10-06-86	305.0	285.0	-	305.0	278.1	-	305.0	Gravel, silt
	P275	09-18-86	170.0	149.5	-	169.5	144.5	-	170.0	Gravel, silt
	P276	05-19-87	315.0	295.0	-	315.0	288.0	-	315.0	Sand, gravel
	P277	05-28-87	400.0	380.0	-	400.0	373.0	-	400.0	Sand, gravel

* Well not completed

TABLE 2. LIST OF SAMPLE SITES TO MONITOR, ROUND 5
(Updated September, 1987)

(102) Private Well Sites			Well Use(s)[3]
	W17	W. Phelps[6]	E, IR
	W22	J. Dansie[4]	D, Ir
	W27	Conoco Station[5]	A
(2)	W31	Copperton[4]	D
(1)	W41A	Bastian	D, Ir
	W107	Westland Hills #1?	Ir, D, St
	W108	Westland Hills #2?	Ir, D
(2)	W125	Nicoletti	K
(2)	W131A	C. Fassio[4]	D, St
	W131B	C. Fassio	D, St
	W134	O. Madsen[4]	D
(2)	W136	Garamedi (Riverton City Well)[4]	D
	W141	K. Motoki[4]	D
	W142	Bills	D, Ir
	W143		
	W144	M. Jensen	D
	W146	D. Boulden[4]	D
(2)	W151	P. Schmidt[4]	D, Ir
	W152	O. J. Wilkinson[4] (well down in 1986)	D
	W153	F. E. Smith	D
(2)	W154	P. Groves[4]	D
	W155	W. Davis (well destroyed)	A
	W162	Leo Palmer	D
(2)	W164	Garrett	D
	W167	Mulch Plant	D
	W173	Hamilton Feed & Livestock	D, Ir
(2)	W174	Gardiner	D
(2)	W176	Peterson[4]	D
	W178	Gardner[4]	St
	W180	Fur Breeders[4]	D, St
	W182	Vance Beakstead[4]	D, St
(2)	W185	Herriman City[4]	D, Ir
(1,2)	W189	Interstate Brick[5]	D, In
(1)	W300	Fraughton[4]	D, Ir, St
(1,2)	W301	Anderson[4]	Ir, D, St
	W302	Naylor[4][5]	Ir
	W304	Farnsworth[4]	Ir, D, St
	W305	Tac	D, Ir
	W306	Gigi[4]	Ir
	W308	Tolbert	D
(1,6)	W309	L. R. Bateman[4]	D
(1,2,6)	W310	Bowles[4]	D
(1,2,6)	W311	Schouton[4]	D
(1,6)	W312	Tidwell[4]	D
(2)	W322	Brent Dansie	D
	W323	L. Wall[4]	D, Ir, St
(2)	W325	J. Holland[4]	D
(2)	W326	Hamilton (Riverton City Well)[4,5]	D
(2)	W327	Maynard (Riverton City Well)[4,5]	D

TABLE 2 (Continued-2)

	Private Well Sites		Well Use(s)[3]
(2)	W328	Gedge (Riverton City Well)[4]	D
(1)	W329	A. Jensen (Webb)	D
	W331	Jay N. Butterfield[4,5]	D
	W332	Paul Solmonsen	D
(1)	W333	Thad Otley[4]	D
	W334	Bob Goldsmith[4]	D
	W335	Dick Kunz	D
	W336	Gary Larsen	D
	W337	Bill Ham[5]	D
	W338	Flossie Wells[5]	D
	W339	R. K. Petersen[4,5]	D
	W340	Harmon	D, Ir
	W341	Murray Fair Grounds[4]	D
	W342	Murray Fair Grounds[4]	D
	W345	D. H. Greenwood	D
	W346	Pine Hollow Tree Farm	D
	W347	D. H. Holtkamp	D
(1)	W348	Blaine Christensen	D
	W359	Hercules	D
	W360	Kelly Schultz	D
(1,2)	W361	West Jordan City Well[5]	D

*NOTE: Wells W373-W396 were picked up in the spring of 1986 to monitor the groundwater quality near and downgradient from Kennecott's new evporation ponds. wells W362-W396 have been added since Round 2.

W362	Norm Jessie	D
W363	City of West Jordan[5]	D
W364	Robinson[6]	D
W365	Gariner[5]	I
W366	Candalot[5]	I
W367	J. N. Hogge[6]	
W368	McLane & Andrews[6]	
W369	K. Rasmussen[6]	
W370	Travis Rasmussen[5]	
W371	Owen Bringhurst[5]	
W372	Craig Peterson[6]	
W373	L. Schouten[6]	
W374	L. Dutson[6]	
W375	C. Butterfield[5]	
W376	B. Butterfield[6]	
W377	C. Butterfield[5]	
W378	B. Dutson[5]	
W379	W. Iverson, Jr.[5]	
W380	B. Coulter[5]	
W381	Sugar Factory	
W382	R. Peterson[6]	
W383	Jenkins[5]	
W384	C. W. Bright[5]	

TABLE 2 (Continued-3)

Well Sites

W385	R. Larson(5)
W386	M. Martin(5)
W387	G. McIntyre(5)
W388	E. L. Pasco, Jr.(6)
W389	G. W. Oakeson(5)
W390	A. G. Smith(5)
W391	Ferhgen(6)
W392	Stephen Phelps(6)
W393	Hocking(5)
W394	D. Gilbert, 12262 S. 3600 W.(5)
W395	R. Wright, 12281 S. 3600 W.(5)
W396	B. Bennett, 12536 S. 3600 W.(5)
W397	Riverton City (Stephenoff)(5)
W398	Riverton City (Maynard #2)
W399	Rowley
W401	At Kennecott Ranch (old well)
W402	Salt Lake City Conservancy District
W403	Salt Lake City Conservancy District

Footnotes for W wells:

(1) Sample for coliform .
(2) Sample for radionuclides (All new monitor wells will be sampled at least once for radionuclides).
(3) Well use codes, based on actual use or permitted use as per the Utah State Engineer's well log records. The first use code designates the key or current use for the wells.
Ir =Irrigation
D =Domestic
K = Kennecott Monitor Well
In = Industrial
A = Abandoned, not used
St = Stock Watering
(4) Well owners who have requested and received water quality data results on their wells.
(5) Will be sampled 4 times/yr. for Round 5.
(6) These are generally sampled monthly as evaporation pond monitor wells for Round 5.
(7) Will be sampled 3 times/yr. for Round 5.

TABLE 2 (Continued-4)

(80) K & P Well Sites[6]

	K26
	K60
(2)	K70
	K72
(1)	K84[5]
(1)	K100
(2)	K105
	K106
(2)	K109
	K120
(1,2)	K201
	K349[5]
	P190A
	P190B
	P191A
	P191B
	P192A
(2)	P192B
	P193A
	P193B
	P194A
	P194B
	P196A
	P197A
	P197B
(2)	P198
(2)	P199
	P202C
(1,2)	P207A
(1)	P207B
(1)	P208A
(1)	P208B
	P209B
	P210B
	P211A
	P211B
	P212A
	P212B
(2)	P213B
(2)	P213C
	P214A
	P214B
	P220
	P225
	P228
	P231
(2)	P234
(2)	P239 replacement near old K67R
(2)	P240A replacement near old P198A[5]
(2)	P240B replacement near old P198B[5]
(2)	P241A replacement near old P202B[5]
(2)	P241B replacement near old P202C[5]

TABLE 2 (Continued-5)

K & P Well Sites[6]

(2) P241B replacement near old P202C[5]
P241C[5]
P242[5]
P243[5]
P244A[5]
P244B[5]
P244C[5]
P245[5]
P246[5]
P247A[5]
P247B[5]
P248A[5]
P248B[5]
P248C[5]
P249A[5]
P249B[5]
P250A[5]
P250B[5]
P251[5]
P252A[5]
P252B[5]
P252C[5]
P253A[5]
P253B[5]
P254A[5]
P254B[5]
P255A[5]
P255B[5]
P256[8]
P257[8]
P258A[5]
P258B[5]
P259[5]
P260[5]
P261[5]
P262[5]
P263[8]
P264[5]

Footnotes in addition to the comprehensive analysis in Table 4-1:

(1) Sample for coliform.
(2) Sample for radionuclides. (All new monitor wells will be sampled at least once for radionuclides).
(5) These sites shall be sampled four times/year for Round 5.
(6) These will be sampled monthly as evaporation pond monitor wells for Round 5.
(7) Will be sampled three times/year for Round 5.
(8) Will be sampled six times/year for Round 5.

TABLE 2 (Continued-6)

K & P Well Sites[6]

P265[5]
P266[5]
P267A[5]
P267B[5]
P268[5]
P269[5]
P270[5]
P271[5]
P272[5]
P273[5]
P274[5]
P274[5]
P275[5]
P276[5]
P277[5]

Footnotes in addition to the comprehensive analysis in Table 4-1:

(1) Sample for coliform.
(2) Sample for radionuclides. (All new monitor wells will be sampled at least once for radionuclides).
(5) These sites shall be sampled four times/year for Round 5.
(6) These will be sampled monthly as evaporation pond monitor wells for Round 5.
(7) Will be sampled three times/year for Round 5.
(8) Will be sampled six times/year for Round 5.

TABLE 2 (Continued-7)

(41) <u>S Sites</u>

(2)	S1	J. River 9000 S.
	S2	J. River 12300 S.[5]
(2)	S21	Butt. Creek above Lark Mine[5]
	S21A	Bingham Mine Portal Drain
(1)	S21B	Butt. Creek and Bingham Mine Portal
	S22A	Lark Town Spring
	S22B	Butt. Creek Spring
	S33	Provo Reservoir Canal 16150 S.
	S33A	Provo Reservoir Canal 9000 S.
	S38	J. River 10,600 S.
	S40	Old Scout Camp Spring
(2)	S53	U.S. Mine Butt. Creek Portal
	S54	J. River 6400 S.
	S56	N. Bingham Creek
	S57	J. River 8000 S.
	S166	J. River 14600 S.
(1,2)	S200	Bingham Reservoir[5]
(2)	S236	Leach Fluid
(2)	S237	Bingham Pit Waters
	S313	J. River 4800 S.
(2)	S314	N. Jordan Canal
	S315	Butt. & Midas Creek
	S316	Crystal Springs
(2)	S317	S. Kennecott Mine Dumps Drainage
(2)	S318	Barney's Springs
	S319	Maple Springs
(2)	S320	Dry Fork Creek
(2)	S321	Midas Creek
(2)	S324	6400 W. 14000 S. Rose Creek
	S330	J. River 9400 S.
	S343	1370 W. 7300 S. (Spring)
	S344	7560 S. 1200 W. (Spring)
	S350	Evaporation Ponds[3,4,5]
	S351	40th West Pond
(1,2)	S352	S. Evaporation Ponds[5]
	S353	Small Reservoir
(1,2)	S354	Treated Mined Stream = old S238 designation
	S355	Nose & Mine Combo. Stream (untreated)
(2)	S356	80 acre pond
	S357	Jordan River eff.
	S358	Cemetery Pond
	S400	Bingham Tunnel (Drinking Water)

Footnotes in addition to the comprehensive analysis in Table 4-1:

(1) Sample for coliform.
(2) Sample for radionuclides.
(5) Will be sampled 4 times/year for Round 5.

3.0 PROJECT ORGANIZATION AND RESPONSIBILITY

3.1 ORGANIZATION

The following gives the organization for the activity:

Kennecott

- Project Manager
  P. W. McCallum
- Technical Manager
  T. A. Himebaugh
- Laboratory Manager
  L. A. Hutchinson
- Staff
  Kennecott Staff

Project Quality Assurance Advisors
Utah Ground-Water Technical And Advisory Groups

- State of Utah Department of Health
- Salt Lake City-County Health Department
- Kennecott
- Dames & Moore
- Intera Technologies

Sampling activities performed by Kennecott environmental technicians will be conducted under the direction of Mr. P. W. McCallum and in accordance with this QA plan.

3.2 RESPONSIBILITIES

The Project Manager will have overall responsibility for direction of the project, quality control, reporting, finance and contracts.

The Technical Manager will prepare QA plans for review and will be responsible for execution of the activity in accordance with the plan.

The Laboratory Manager will prepare Quality Assurance laboratory plans and reports for review semi-annually and will be responsible for execution of the activity in accordance with the plan.

The Project Quality Assurance Advisors will 1) review and advise on the QA plan, 2) review all quality control data, 3) identify problems and recommend corrective action as necessary, and 4) prepare a brief written statement at least annually in the yearly progress report, addressing precision and accuracy of the monitoring data, results of performance sample analyses, results of EPA/State audits, and corrective actions taken, pertinent to the project activity, as per the Laboratory Manager's semi-annual Quality Assurance laboratory reports.

3.3 HEALTH AND SAFETY

Kennecott employees are required to have MSHA training and must obey OSHA rules and regulations. Kennecott will ensure that all authorized visitors will be informed of the proper safety requirements and required equipment.

The field water quality sampling work includes very little risk with respect to potential accidents and safety, since Kennecott's contaminants are not toxic organic chemicals and sampling equipment is mostly automated. However, the monitor well drilling programs do involve substantially more risk with respect to potential accidents and safety.

Consequently, Kennecott requires, by terms of written contract document, that the contractor comply with the following:

Protective Equipment

Hard hats, meeting OSHA/MSHA requirements and manufactured of a non-electrical conducting material, safety glasses and hard toed safety shoes, as approved by Owner, will be provided by Contractor and will be worn at all times by Contractor's or subcontractors' personnel or any other persons entering Owner's property on behalf of Contractor. Other protective equipment will be utilized as specified in applicable statutes, rules or orders in effect in the State of Utah and as specified by Kennecott.

Accident Prevention

Contractor must comply, and must enforce compliance by all subcontractors, with the highest standards of safety and accident prevention found in any of the following: (a) applicable laws, ordinances, building and construction codes, orders, rules and regulations (including those of Owner); (b) the latest edition of the "Manual of Accident Prevention in Construction" as published by the Associated General Contractors of America, Inc.; (c) the latest edition of the "Accident Prevention Manual for Industrial Operations," as published by the National Safety Council, Inc.; (d) the latest edition of the Utah Occupational Safety and Health Rules and Regulations" published by the Utah State Industrial Commission, and (4) the latest edition of the Federal Mine Safety and Health Act.

Laws, Ordinances, Permits, and Licenses

All articles and materials furnished hereunder will comply with such provisions of the Federal Occupational Safety and Health Act of 1970, and the Federal Mine Safety and Health Amendments Act of 1977 and regulations under said Acts as apply to the possession and use of such articles and materials by Owner and its agents and employees. In addition, Contractor shall advise Owner of any hazard or toxic substance which is present in, or may be encountered by, Owner and its agents and employees in using or possessing the articles or materials furnished hereunder and Contractor shall use its best efforts to minimize the hazard or toxicity thereof.

In the extent that the work contemplated herein requires the Contractor to conduct its activities in areas which are subject to the jurisdiction of Federal Mine Safety and Health Administration, State Occupational Safety and Health Acts, and/or Federal Occupational Safety Health Act of 1970 (herein collectively referred to as MSHA/OSHA Laws), Contractor shall use its best efforts to obtain a Contractor identification number as may be required or authorized under the MSHA/OSHA Laws. Contractor shall be responsible for compliance by Contractor and its subcontractors with all standards, rules and regulations promulgated under applicable MSHA/OSHA Laws and shall be responsible for any citations or orders issued thereunder arising out of work to be performed pursuant to this contract, including any assessment levied in connection therewith. Contractor agrees to hold Owner harmless from any citations or orders, or any assessments levied in connection therewith, issued pursuant to any MSHA/OSHA Law relating to, or arising out of, the work to be performed by Contractor, or any of its subcontractors, including reasonable attorneys fees incurred by Owner. The contract price set forth in the Agreement includes the cost of compliance with all MSHA/OSHA Laws, and applicable standards, rules and regulations promulgated thereunder, and Owner shall not bear any portion thereof.

4.0 ANALYTICAL PARAMETERS AND QA OBJECTIVES

Analytical parameters, their detection limits, method of analysis and hold times are given on Table 4-1. Specific conductance, carbonate, bicarbonate, temperature and pH will be measured in the field.

Acceptance criteria for routine laboratory QC checks will be within plus or minus two standard deviations of the precision and accuracy data as specified in the appropriate EPA methodology (Reference 5) and established by the certified laboratory.

TABLE 4-1

LABORATORY ANALYTICAL PARAMETERS AND METHODS

Parameter	Detection Limit (1)	EPA (10/26/84) Method No.	Maximum Hold Time
pH	±0.1 units	150.1	(3)
Specific conductance	±2% umhos/cm	120.1	(3)
Total dissolved solids	10.0	160.1	7d
Total suspended solids	1.0	160.2	7d
Aluminum	0.1	202.1	6mo
Arsenic	0.004	206.2	6mo
Barium	0.3	208.1	6mo
Cadmium	0.001	213.1	6mo
Chromium	0.01	218.1	6mo
Copper	0.02	220.1	6mo
Iron	0.03	236.1	6mo
Lead	0.01	239.2	6mo
Manganese	0.01	243.1	6mo
Mercury	0.0002	245.1	28d
Molybdenum[(10)]	0.1	246.1	6mo
Calcium	0.1	215.1	6mo
Fluoride[(10)]	0.1	340.2	28d
Magnesium	0.1	242.1	6mo
Potassium	0.1	258.1	6mo
Sodium	0.1	273.1	6mo
Carbonate	5.	310.2	(3)
Bicarbonate	5.	310.2	(3)
Chloride	1.0	325.2	28d
Nitrate (as N)	0.02	353.1	48hrs
Sulfate	3.0	375.2	28d
Alkalinity[(10)]	5.0	310.2	14d
Zinc	0.01	289.1	6mo
Selenium	0.004	270.2	6mo
Silver	0.01	272.1	6mo
Coliform bacteria[(4)]	2.0 mpn/100ml	908(8)	30hr
Radium-226[(6)]	0.05pCi/l	706(8)	6mo
Gross Alpha[(6)]	3.0 pCi/l	703(8)	6mo
Gross Beta[(6)]	0.1pCi/l	703	6mo
Endrin[(5,7)]	0.0001	509(8)	7d
Lindane[(5,7)]	0.001	509	7d
Methoxychlor[(5,7)]	0.001	509	7d
Toxaphene[(5,7)]	0.001	509	7d
2,4-D[(5,7)]	0.001	509	
2,4,5-TP Silvex[(5,7)]	0.001	509	
Phenols (Phenolics, Total Recoverable)[(5,7)]	0.005	420.2	28d
Orthophosphate as P	0.02	365.3	
Silica as SiO2	10.0	370.2	
Nickel	0.04	249.1	6mo
Hardness[(10)]	10.0	130.1	
Acidity[(10)]	±10.	Technicon method	14 days

Parameter	Detection Limit (1)	EPA (10/26/84) Method No.	Maximum Hold Time
Temperature	1.	170.1	
Total Organic Carbon (TOC)(4,5)	.01	415.2	28d
Total Organic Halogen (TOX)(5,7)(10)	.25	9020(2)	

Footnotes:

(1) All units in mg/l unless otherwise noted.

(2) EPA, 1982, Test Methods For Evaluating Solid Waste: EPA SW-846, July 1982.

(3) These parameters will be measured in the field.

(4) Coliform shall, after Round 1 sampling, only be monitored at sites: S-200, 238, 352, 21B; 201; P-207a, 207b, 208a, 208b; W-41a, 189, 300, 301, 309, 310, 311, 312, 329, 333, 348 (As agreed to by the Technical and Advisory Groups since Round 1 sampling showed insignificant concentrations and the fact that Kennecott's contaminants do not include these parameters).

(5) Analysis for organics, phenols TOC and TOX were deleted after Round 1 analytical result evaluations by the Technical and Advisory Groups because of insignificant concentrations, and the fact that Kennecott's contaminants do not include these parameters.

(6) Radionuclides will be analyzed by CEP Laboratory, Santa Fe, New Mexico, which is EPA certified for such analysis.

(7) Will be analyzed by Kennecott's laboratory, Salt Lake City.

(8) APHA-AWWA-WPCI, 1981, Standard Methods for Examination of Water and Wastewater: American Public Health Association, 15th ed.

(9) Temperature reported in °C.

(10) These parameters have been dropped after Round 1 sampling by the Technical and Advisory Groups because of insiginficant concentration.

NOTE: Metals concentrations have been determined on a "dissolved" basis. Total metals concentrations are available and have been analyzed since Round 1 (1983-1984) sampling. This has been conducted as part of Kennecott's quality assurance.

5.0 SAMPLING PROCEDURES AND SCHEDULE

5.1 SAMPLE SITES

Existing sample sites September 1987 are listed in Table 2. New ground-water monitoring well locations (Phase I and Phase II drilling) and construction are as specified in Reference 9, attached, as per Reference 10 and as agreed upon by the Ground-Water Technical and Advisory Group members from Kennecott, the Utah State Division of Environmental Health and the Salt Lake City-County Health Department. Well construction materials shall be either PVC, galvanized or stainless steel and shall be properly grouted to monitor specific zones, as detailed in Reference 9.

New monitor well construction, design and sampling have been designed as per the objectives of Reference 10 and as per approval by the Technical and Advisory Groups (appropriate government officials, page 13, Reference 10).

Specifically, as per Reference 10:

1. The drilling methods to be used will: a. accomplish the job and b. not introduce contamination or significant disturbance into the formation monitored. The preferred drilling methods are, in order: 1. Air Hammer, 2. Cable Tool, 3. Air Rotary. Mud Rotary drilling will be considered as a last resort. Validity will be demonstrated by field conductivity measurements during and after well development, visual observation of the quality of the well waters during surging and laboratory measurement of suspended solids.

   Deep wells (e.g.>600 feet) to evaluate vertical water quality may be drilled using mud rotary and geophysically logged to evaluate water quality and lithologic changes with depth.

2. NSF approved PVC and/or 316 stainless steel casings (and/or other suitable pipe above the water table in areas of noncontaminated waters where casing materials will be non-reactive) shall be used since Kennecott does not have organic contaminants (i.e. phthalate or vinyl chloride from PVC).

3. Gravel pack will be clean Colorado silica sand and will only extend above the screen far enough to ensure that a representative water sample can be obtained, and to limit the vertical sample area to a permeable zone, and a bentonite seal shall be placed above the pack and the remainder of the annular space shall be tremied with a cement or grout mixture.

4. Wells shall be developed to produce as turbid-free water as possible.

5. Wells shall be screened over as small a zone as practicable.

6. Well diameters shall be 4 inches I.D.

7. Wells shall be sampled with a state approved submersible pump, since organic contaminants are not present.

Existing (pre-1984) ground-water monitor well locations and construction were installed prior to the start of the 5-year Ground-Water Study. Data on these wells are included in reference 1. Pre-1984 Kennecott monitor wells are constructed out of PVC or steel casing. Private water wells are generally constructed out of steel casing. Data from these wells will be used in conjunction with data from new QA'ed wells.

Phase II ground-water monitoring well locations and construction, scheduled for 1986 - 1987, have been specified. These wells were approved by the Technical Group prior to construction, and located to monitor the ground-water quality near those Kennecott facilities which are contributing to ground-water contamination. Determination of the locations and depths was based on the ground-water quality data obtained from the Phase I monitor wells. Exact well construction details were finalized by Dames & Moore and Kennecott, in the field.

5.2 SAMPLE COLLECTION

Prior to sampling, the wells will be purged with a submersible pump or a bailer. A minimum of three casing volumes and a maximum of five casing volumes will be purged before sample collection. The volume will be consistent per well as sampling dictates. The volumes will be computed based on the equation (r^2h)/7.48 gallons, where r(ft) is the well radius, h(ft) is the distance from the static water level to the well bottom. This volume is multiplied by 3 or 5, depending on the number of casing volumes to be removed. The volumes pumped will be measured using a 5 gallon bucket and stop watch. However, for the older Kennecott monitor wells constructed of steel pipe which intercept low pH waters, in order to clean the well thoroughly, 10 casing volumes maximum may be taken out prior to sampling (Reference 10). The submersible pump and intake hose shall be thoroughly cleaned between well sample sites by flushing the pump and hose via pumping for at least 30 minutes (with waters of drinking water quality) or until the pH and conductivity levels stabilize to approximately 7 pH units and 1000 umhos/cm. A transfer blank shall be run periodically to ensure proper cleansing of the pump.

For each sample, the form given in Table 5-1 should be filled out completely. Each sample for laboratory analysis will be placed in a series of containers, with the appropriate preservatives as summarized in Table 5-1.

Sample containers should be placed out of direct sunlight, preserved, shipped and analyzed within the maximum allowable hold times as specified in Table 4-1. The preservation methods indicated conform to the requirements of Reference 4. Samples should be shipped to the laboratory as soon as possible, preferably the same day as collection. These methods call for the use of various specific type containers, addition of preserving agents, refrigeration (certain sample bottles should be immediately placed and shipped on ice), and be analyzed by the laboratory within the maximum hold times.

Blank and duplicate samples will also be taken in the field as outlined in Section 10.0.

Sample labels, field sampling and analysis records, and chain-of-custody records will be prepared as outlined in Section 6.0.

During the sampling, static water level, pH, specific conductance, temperature, carbonate and bicarbonate measurements will be made at each site and recorded on the form shown on Table 5-1. Measurements will be made in small sample containers. The meters used to measure pH and conductivity and procedures used for calibration are outlined in Section 7.0.

ph meter I.D. number______

Conductivity meter I.D. number______

TABLE 5-1. UCD HYDROLOGIC STUDY FIELD WATER QUALITY DATA SHEET

Sample Site Designation	Time and Date	Pre-Pumping Depth to Water From Top of Casing (Tenths of Feet)	Initial Conductivity umhos/cm	Final Conductivity umhos/cm At Sample (1) Collection	Temp. °C	Well Volumes Removed	ph	Carbonate CO_3 mg/l	Bicarbonate HCO_3 mg/l	Miscellaneous Information (i.e. visual description of well and water)	Well Owner & Address	Weather

Check Samples Collected

Container and Preservative

Ref. No.		Container and Preservative
1.	______	2 liters, unfiltered, acidified HNO_3 to pH 2, into a plastic container
2.	______	2 liters, filtered with .45 micron filter paper, acidified HNO_3 to pH 2, into a plastic container
3.	______	2 liters, unfiltered, cool 4°C, plastic container
4.	______	100 ml, unfiltered, acidified H_2SO_4 to pH 2, into a plastic container
5.	______	1 liter, unfiltered, cool 4°C, pH 5-9, full to top in a glass bottle with a teflon lid
6.	______	1 liter, unfiltered, cool 4°C, pH 5-9, full to top in a glass bottle with a teflon lid
7.	______	2 liters, unfiltered, acidified with H_2SO_4, pH 2, in a glass bottle with a teflon lid
8.	______	4 ounces, unfiltered, cool 4°C, into a sterilized glass bottle (avoid body contact with sample)
9.	______	1 liter, unfiltered, acidified with HNO_3, pH 2, into a glass bottle
10.	______	40 ml, unfiltered, preserved with $Na_2S_2O_3$, into a glass bottle full to top with teflon lid

Parameters For Analysis:

1. For Total Metals
2. For Dissolved Metals
3. For F, CO3, HCO3, AlK, Cl, SO4, pH, SC, TDS, TSS, Ca, P, Temp, Na, SiO2, K
4. For Nitrate
5. For Herbicides
6. For Pesticides
7. For Phenolics
8. For Coliform
9. For Radionuclides
10. For TOX

All sample bottles shall be labeled with:

Site Name:
Date:
Preservative:
Filtered: ______ /Unfiltered: ________
Sampler's Name: ____________________

5.3 SAMPLING SCHEDULE

Due to the fact that the environmental technicians conducting the water quality sampling for this study also conduct other environmental monitoring and are frequently involved in emergency field work, an exact well-by-well time sampling schedule cannot be defined.

However, it is possible to define a general sampling schedule, based on seasonal limitations, with respect to access to certain well areas and based on the fact that certain well sites are sampled three (3) times per year. For purposes of duplicate sampling, by the state and county, of specific well sites, the following general schedule should aid in defining approximate times for sampling specific sites. Specific sites should be so designated and Kennecott's environmental technicians can then make it a point to notify the appropriate people of exact times and dates at which the sampling will be conducted.

GENERAL SAMPLING SCHEDULE (Annual)

SPRING

1. Start sampling wells along the dumps (3/yr)
2. Sample wells along Bingham Creek
3. Sample wells in the Evaporation Pond Areas
4. Sample wells along Butterfield Creek
5. Sample private wells (dependent on homeowner being at home)
6. Surface water sample sites

SUMMER

All sample sites to be sampled three (3) times per year will be resampled in the summer, in the same order as outlined above.

FALL

Same as for summer

WINTER

Due to Kennecott monitor well access problems in the winter, generally only private wells are sampled.

* Due to the fact that the Kennecott lab is not operating at full capacity on the weekend, only the sites associated with mining operations and requiring less analysis are sampled on Fridays.

6.0 SAMPLE CUSTODY

6.1 FIELD OPERATIONS

An essential part of the sample collection activity is the documentation of site measurements and the ensuring of the integrity of the sample from collection to data reporting. This includes the ability to trace the possession and handling of samples from the time of collection through analysis and final disposition. This documentation of the history of the sample is referred to as chain-of-custody. The following records and actions will be taken.

1. Sample Labels - Sample labels are necessary to prevent misidentification of samples. The sample label shown on Table 6-1 should be completely filled out and attached to the sample at the time of collection.

2. Field Sampling and Analysis Record - Pertinent field measurements and observations should be recorded. To facilitate these records the form shown on Table 5-1 should be filled out for each sample. Documentation of the sources of buffers, standards, reagents, sample containers, etc., should be recorded in the laboratory.

3. Chain-of-Custody Record - To establish the documentation necessary to trace sample possession from the time of collection, the chain-of-custody record as shown in Table 6-2a should be filled out to accompany every sample shipment from the time of collection through receipt by the analytical laboratory. The sample should be delivered to the laboratory for analysis as soon as possible, usually within one day after sampling. Maximum hold times are shown in Table 4-1.

   The date of sample laboratory logging is shown by the Julian date, the analytical control number and the date of field sampling are indicated in the upper right hand corner. An example sheet is included (Table 6-2b). The types of analyses conducted are indicated by the codes on the "Master Sheet Guide" (Table 6-2c) which the field sheet specifies.

TABLE 6-1

SAMPLE LABEL

PROJECT: UCD 490088

SITE NAME: ______________________________

DATE: ______________________________

PRESERVATIVE: ______________________________

FILTERED: ______________ UNFILTERED: ______________

SAMPLER'S NAME: ______________________________

6.2 LABORATORY OPERATIONS

The laboratories used will be State of Utah or EPA certified. The QA document for CEP laboratory has been submitted to the State for approval. The laboratories will maintain internal chain-of-custody control in accordance with their own standard quality assurance program.

Kennecott Corporation

KMC—Process Technology · ENVIRONMENTAL ANALYSIS & INDUSTRIAL HYGIENE LABORATORY

TABLE 6-2a

ANALYSIS REQUEST

REQUEST NUMBER ___ ___

SAMPLES SUBMITTED BY: ______________________

TELEPHONE: ____________ DATE: ____________

WORK CENTER: ____________ CHARGE NUMBER: ____________

GENERAL SAMPLE DESCRIPTION:

SAMPLE ORIGIN: ______________________

SAMPLE TREATMENT:

SAMPLE		ANALYSIS REQUESTED														
		UNITS														
NUMBER	DESCRIPTION															

REQUEST FOR PRIORITY HANDLING

(SUPERVISOR'S SIGNATURE REQUIRED)

____

APPROVED:

TABLE 6.2b EXAMPLE SHEET

Kennecott Corporation
KMC–Process Technology · ENVIRONMENTAL ANALYSIS & INDUSTRIAL HYGIENE LABORATORY
ANALYSIS REQUEST

REQUEST NUMBER

SAMPLES SUBMITTED BY: Bob McKee

WORK CENTER: 231 CHARGE NUMBER: 231432

SAMPLE ORIGIN: UCD

SAMPLE TREATMENT:

JULIAN DATE
TELEPHONE: 6645 DATE: 1-4-85 SAMPLE DATE

GENERAL SAMPLE DESCRIPTION: Valley Wells W-41A, W-125, W-136

SAMPLE NUMBER	SAMPLE DESCRIPTION	ANALYSIS REQUESTED / UNITS				
0500186	WW-41A-850104-R007651- TOTAL					
87	Disolved					
88	WW-125-850104-R007652- TOTAL					
89	Disolved					
90	WW-136-850104-R007653- TOTAL					
91	Disolved					
	Field DATA	pH	COND	Temp	C	bi
	W-41A	6.6	1310	5°	0	5.2
	W-125	6.8	3400	14°	0	5.1
	W-136	6.8	675	13°	0	5.6

REQUEST FOR PRIORITY HANDLING
SUPERVISOR'S SIGNATURE REQUIRED

Copy sheet #7740008

SAMPLE ANALYSIS DESIGNATION (Table 6.2c)

Field And Lab Signatures

APPROVED:

* The field technician = sh[illegible]

KMC–PT–

TABLE 6-2c

KENNECOTT ENVIRONMENTAL LABORATORY
MASTER CONTROL GUIDE
REVISION I

Oct. 5, 1987

Master Sheet and Reference Guide

Sheet No.	Sample Descript.	Parameters
7740001	**NPDES** SAMPLES (4#) **001,003** Tot, Dis	pH,Cond,Temp,Flow,TSS,Cu,As,Cd,Pb, Zn,Hg,Ni,Se,CN,BOD5,O&G,PHOH,Colif
7740002	7740001 2 #	
7740003	**Mine Surface H2O** VWS350-358	pH,Cond,Temp,Cu,Fe,As,Mn,Mg,Zn,Al, Pb,Se,Ni,SO4,Phenol,TDS,Colif,Cl, Ca,Na,K
7740004	**Tailing Pond Seeps**	pH,Cond,TDS,SO4,NO3,NO2,CN,Ba,Cd, As,Cr,Cu,Pb,Hg,Se,Mo,Ni,Temp
7740005	**NPDES MINE** (6#) Jordan River,#1,#2	pH,Cond,Temp,Flow,Tss,Cu,As,Cd,Pb, Ni,Zn,Hg,Fe,Mn,TDS,O&G
7740006	**GARFIELD WELLS**(16#) #1,2,3,4,5,6,6A,7 Total and Dissoved	pH,Cond,Temp,Cu,As,Mn,Se,Pb,Cr,Cd, Ni,Mg,Na,K,Ca,Cl,TDS
7740007	NMD WATERS Tot & Dis 9#	pH,Temp,TDS,Tss,Cond,Sb,As,Ba,B,Cd Ca,Cr,Cu,Fe,Pb,Mg,Mn,Hg,Ni,K,Se,Ag Na,Zn,Alk,Cl,CN,F,Hard,NO3,NO2,SO4 CO3,HCO3
7740008	**DRINKING H2O WELLS** 8# 4 Tot & Dis	pH,Cond,Cu,Fe,As,Mn,Zn,Al,Mg,Pb,Se Ni,Ba,Cd,Cr,Ag,Hg,Na,NO3,NO2,SO4, TDS,PHOH,Cl,Coliform,Ca,Temp,Be,K
7740009	**SMELTER H2O** 3#	As,Cd,Cr,Pb,Hg,Se,Cu,Mo,Ni,TDS,TOC
7740010	open	
7740011	**MINE H2O STUDY** Tot & Dis 4#	pH,Cond,Temp,CO3,HCO3,Cu,Fe,As,Mn, Zn,Al,Mg,Pb,Se,Ni,Ba,Cd,Cr,Ag,Hg, Na,NO3,NO2,SO4,TDS,PHOH,Cl,Colif Be,Ca,K
7740012	**PLANT MONITORING** (6#-3 samples)	Cu,Pb,Zn,Mn,Ni,As,Cd
7740013	open	

TABLE 6-2c (Continued)

7740014	Original Mine Study short list	Use 7740011
7740015	Original Mine Study long list	Use 7740011
7740016	open	
7740017	Dames&Moore New Wells(2#)	pH,Cond,Temp,Depth,TDS,TSS,Al,AS, Ba,Cd,Cr,Cu,Fe,Pb,Mn,Hg,Mo,Ca,Mg, K,Na,Se,Zn,Ag,Cl,SO4,ALK,ACD

7.0 CALIBRATION PROCEDURES AND FREQUENCY

7.1 GENERAL

Meters used to measure pH and specific conductance will be calibrated as outlined below prior to and during use. Source and identification (lot number, etc.) of standards used to calibrate will be recorded; identification numbers of the instruments used will also be recorded.

7.2 FIELD pH

Field pH is to be performed with one of the following, or an equivalent instrument, which are automatically corrected to a temperature of 25°C.

Manufacturer	Model No.	Serial No.
Fisher	805MT	2937
Orion Research	211 Digital	214694
Orion Research	407A	3620

Follow manufacturer's instructions for operation and standardization of instruments. Perform two-buffer standardization with buffers approximately 3 pH units apart and spanning the anticipated measurement values prior to first use and before each measurement where occasional pH measurements are made. Where frequent measurements are made, less frequent standardization (every 1 or 2 hours) is satisfactory. However, if sample pH values vary widely, standardization will be more frequent.

Standardization and measurement procedures should be in accordance with those contained in References 3 and 4.

Notes:

1. If oil gets on the electrodes, clean the electrodes with acetone or hydrochloric acid (1 to 9), as necessary.

2. Store pH electrode in pH 7 buffer.

7.3 FIELD SPECIFIC CONDUCTANCE

Field specific conductance measurements are to be done with the following, or equivalent instrumentation:

Manufacturer	Model No.	Serial No.
Yellowsprings (YSI)	33	9042

Specific conductances are corrected to 25°C for computer printout results. Wet standardization methods (KCL standard solution) as per manufacturer's instructions, are to be used. Calibration is to be done before each sample site measurement.

7.4 TEMPERATURE

Temperature should be measured using a good grade ASTM temperature certified thermometer. Temperature should be reported to the nearest 1°C.

7.5 WATER LEVEL METERS

Electric water level meters will be calibrated prior to use, with 5-foot tape measurements to verify the footage intervals, prior to the start of the annual sampling program [and at any time when the footage marker(s) slips or cable breaks].

7.6 WATER LEVEL MEASUREMENTS

Static water level measurements will be measured from the top of the well casing (at the same marked point each time), prior to well water sampling. Water levels will be measured to the nearest .01 foot using the electric water level meter and a steel tape, calibrated in tenths and hundredths of feet.

All Kennecott monitor wells have steel caps with locks to prevent any well tampering between sampling rounds.

8.0 ANALYTICAL PROCEDURES

Analytical procedures to be used are listed in Table 4-1.

9.0 DATA REDUCTION, VALIDATION AND REPORTING

Analytical results will be reviewed on the original laboratory certificates of analysis. The laboratory will calculate and report an ion balance for waters which are not significantly contaminated (i.e. less than 1500 mg/l TDS) based upon major constituents for each sample. Reported concentrations and ion balances will be reviewed. Unusually large or small concentrations will be identified and reanalysis ordered. Outliers will be identified based upon ion balances, comparisons with other samples, and results of internal quality control checks (Section 10.0). Original laboratory certificates of analysis will be used to report analytical results. Key individuals and responsibilities are given in Section 3.0.

10.0 INTERNAL QUALITY CONTROL CHECKS

10.1 FIELD OPERATIONS

Blind field duplicates will be prepared and submitted to the laboratory by Kennecott personnel. One out of every 10 samples will be blind field duplicates. Splitting for duplications will be done by pumping waters and simultaneously filling sample containers. The Technical Group agreed that the Salt Lake County Health Department will split samples on a frequency of one full day of sampling per month, and that the county laboratory will analyze those parameters that they are certified to analyze for. The County will submit a QA document to the State for approval.

Five percent field blanks will be collected per annual sample round. The blank sample will consist of distilled water poured into sample containers.

10.2 LABORATORY OPERATIONS

The laboratory will conduct its own internal quality control checks in accordance with its own QA program as a part of State certification. This will include running at least 10 percent duplicate, spike and control samples. The laboratory will summarize the results of these quality control checks and submit them with the analytical results as part of the semi-annual quality assurance reports.

11.0 PERFORMANCE AND SYSTEM AUDITS

The results of all analyses and quality control checks will be reviewed by the Kennecott laboratory prior to computer input. Existing regulatory performance audits (i.e. state and federal will be provided for each round of sampling and included in each yearly report) will be carried out after each round of sampling and a written report prepared after the round is completed as outlined in Section 15.0.

12.0 PREVENTIVE MAINTENANCE

Conductance and pH meters and probes will be cleaned with acetone or hydrochloric acid (1 to 9) as necessary and rinsed with distilled water and checked after each sampling period and any problems reported to the technical manager and recorded on the field sheets.

Laboratory equipment maintenance will be followed as per the Laboratory QA/EPA certified plan.

13.0 PROCEDURES USED TO ASSESS DATA PRECISION, ACCURACY AND COMPLETENESS

Data generated during ground-water sample collection will be evaluated qualitatively based on the extent to which procedures were followed, instrument performance and other factors. The precision, accuracy, and completeness of the analyses of quality control samples will be assessed using the procedures described in this section. The laboratory will provide the technical manager with their analytical control limits.

Quality control samples will consist of field blanks and blind duplicate ground-water samples. The field blanks and blind samples will verify the absence of field contamination and analytical precision. The standard deviation and mean of all the recovery percentages will be calculated for each parameter.

Satisfactory limits for precision, accuracy and completeness will be judged with respect to the QA objectives given in Section 4.0.

14.0 CORRECTIVE ACTION

Corrective action will be undertaken if sample collection deficiencies or unreliable analytical results prevent QA objectives for the project from being met. The criteria for acceptable sample collection data are given in Section 5.0 and the laboratory's QA program provides the criteria for acceptable analytical results.

Analytical results supplied by the laboratory will have been subjected to the laboratory's QA plan and will be considered by the Technical Group to be acceptable unless the results significantly contradict prior knowledge of the site conditions. When this situation occurs, the Technical Group will request that the laboratory review the quality control documentation for the sample or analysis in question. Further corrective action will be based on the specific details of the situation.

The principal corrective action that may be required as a result of deficiencies in sample collection is resampling if one or more of the following problems occur:

1. Gross contamination due to sample collection errors rendering the entire sample useless.

2. Wide variation between duplicate analyses of a parameter.

3. Loss of a sample in transit to or in the laboratory.

4. Violation of holding times for particular, especially critical, parameters.

Because over 150 water samples will be collected each year, resampling will be required only if corrective action is necessary. Reanalysis may be substituted for resampling if the holding time has not expired and the sample condition is satisfactory.

A request for corrective action may be initiated by the project manager or the technical group, but final approval for major corrective action must come from the Advisory Group.

15.0 QA REPORTS

A QA report will be prepared following the completion of the annual sampling period when the laboratory analyses are available. Specifically, the report will address the following areas:

- Results of system and/or performance audits of sample collection activities.
- Summary of the laboratory QA report.
- Listing and basis for any unacceptable data.
- Significant QA problems and recommended solutions.

The QA report will be prepared by the Laboratory Manager and Technical Manager and Technical Group. The final report for the project will contain a QA section which will summarize the data quality information, to include a discussion of QA discrepancies and a list of corrective actions.

16.0 REFERENCES

1. Kennecott, with input and approval by the Utah Ground-Water Technical and Advisory Groups, June, 1984, Report I, Geologic, Ground And Surface Water Data Background And Progress Report Of Kennecott's UCD Mine Hydrogeologic Study.

2. Dames and Moore, Kennecott, with input and approval by the Utah Ground-Water Technical and Advisory Groups October, 1984, Environmental Assessment Status Report for Kennecott's UCD Mine Hydrogeologic Study.

3. EPA, 1983, Characterization of Hazardous Waste Sites - A Methods Manual, Volume II. Available Sampling Methods: EPA-600/4-83-040.

4. EPA, 1982a, Test Methods-Technical Additions to Methods for Chemical Analysis of Waters and Wastes: EPA-600/4-82-055.

5. EPA, 1979, Handbook For Analytical Quality Control For Water Laboratories: EPA 600/4-79-019, March 1979.

6. EPA, 1982, Handbook For Sampling and Sample Preservation of Water and Wastewater.

7. EPA, 1979, Methods For Chemical Analysis of Water and Wastes: EPA-600-4-79-020.

8. EPA, 1982b, Test Methods For Evaluating Solid Waste, Physical/ Chemical Methods: EPA SW-846, 2nd Edition.

9. Phase I and Phase II and Phase II Monitoring Well Construction Specifications For Utah Copper Division, Kennecott, March, 1985; August, 1986.

10. EPA, 1985, Draft Chapter 3 to SW-846.

TABLE 1. LIST OF CURRENT (1987) TECHNICAL, ADVISORY AND CITIZEN'S GROUP MEMBERS

Technical Group Members

Nolan Jensen, Bureau of Solid & Hazardous Waste, Division of Health
Ursela Trueman, Bureau of Solid & Hazardous Waste, Division of Health
(1)Joel Hebdon, Bureau of Solid & Hazardous Waste, Division of Health
Linda Moore, Bureau of Public Water Supplies, Division of Health
Steve R. McNeal, Bureau of Water Pollution Control, Division of Health
Kent Miner, Salt Lake City-County Health Department
Marv Maxell, Assistant Director, Division of Health
(1)Ken Bousfield, Compliance Program manager, Public Water Supplies, Division of Health
(1)Kent P. Gray, Bureau of Solid & Hazardous Waste, Division of Health
(1)Steven D. Taylor, Kennecott, UCD Environmental Director
(1)Terry Vandell, Kennecott Environmental Affairs
Peter W. McCallum, Kennecott Environmental Quality
Theodore A. Himebaugh, Kennecott Environmental Services

Non-Voting Members

George Condrat, Dames & Moore Consultants
Ric Jones, Dames & Moore Consultants
Joe Pearson, Intera Technologies
Ron Lantz, Intera Technologies
Mack G. Croft, Environmental Scientist, Division of Environmental Health

ADVISORY GROUP MEMBERS

Terry Sadler - Director, Division of Environmental Health, Salt Lake City-County Health Department
(1)Harry Gibbons, Director, Division of Environmental Health, Salt Lake City-County Health Department
Ken Alkema, Director, Utah State Division of Health
(1)Robert A. Malone, Director, Kennecott Environmental Division
Gregory H. Boyce, Director, Kennecott Health, Safety and Environmental Quality

OTHER AGENCIES INVOLVED (informally)

Rob Walline, EPA Region VIII
Calvin Clyde, Utah State University, Water Research Laboratory
Tom Suchoski, State of Utah Natural Resources, Oil, Gas and Mining
Gary E. Christenson, State of Utah Natural Resources, Utah Geological and Mineral Survey
Galen Williams, South Jordan City (Bingham Engineering)
Terry Bailey, City of Riverton
Terry Way, Salt Lake City-County Health Department

Footnote:
(1) No longer active in the group.

OTHER AGENCIES INVOLVED (INFORMALLY)

Representing	Name
West Jordan City	Betty G. Naylor
South Jordan	Richard Warne
Riverton	Terry Bailey
Herriman	J. Bryant Miller
Bluffdale	No designated representative
Copperton	No designated representative
County Commission	Bart Barker
Public Water Users	Robert B. Hilbert
Agriculture	Dale Bateman
Water Research Laborator	Dr. Calvin Clyde
AWWA	Dr. Michael Miner

FILE ________ BY ________ DATE ________ CHECKED BY ________ DATE ________

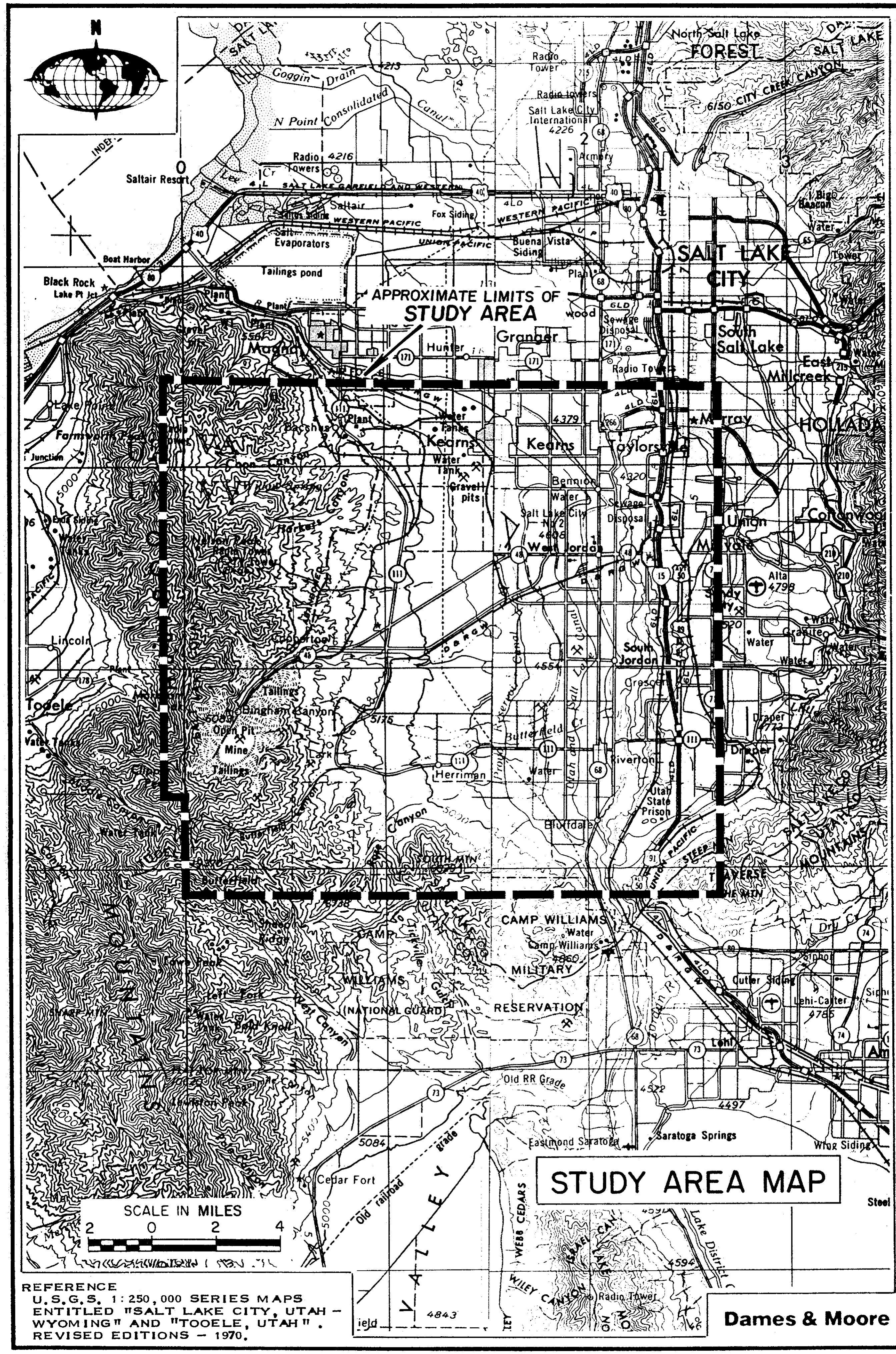

FIGURE 1

JOINT KENNECOTT HYDROGEOLOGIC STUDY PLAN, QA/QC VARIANCES[(1)]

Variance	Date(s) Discussed with Technical Group	Backup Document	Impact on QA/QC	Recommended Action (If Required)
Section 4				
Items 1, 2, 4 Incomplete data for CO_3, HCO_3, specific conductivity, and lab analyses for some parameters missing.	8/15/86 2/17/87	Letter to Technical Group from S. D. Taylor Technical Group meeting	None	These data are listed on the field data sheets. HCO_3 and CO_3 are not run on low pH waters since the HCO_3 and CO_3 levels are so low and cannot be titrated in the field. Where field data are incomplete, there is enough historic data to adequately evaluate the water quality.
Item 3 Routine lab QC checks not reported in Annual Reports	6/87	Report IV Appendix H	None	The laboratory QA Documentation Report presented in Appendix H of the last annual report presents a concise summary of the QA/QC laboratory program. The "Kennecott drill hole water system" computer program is presented in Appendix H. It flags outlier data points and is used by Kennecott's laboratory for QA/QC. Results are on file at Kennecott's laboratory. The Technical Group members are welcome to view these records and any other procedures at Kennecott's laboratory facilities.

(1) Reference August 31, 1987 letter from Ken Alkema, Director, Utah Division of Environmental Health to Gregory H. Boyce, Kennecott, Environmental Affairs Director.

JOINT KENNECOTT HYDROGEOLOGIC STUDY PLAN, QA/QC VARIANCES

Variance	Date(s) Discussed with Technical Group	Backup Document	Impact on QA/QC	Recommended Action (If Required)
Section 5.0				
Item 1 (State approval of submersible sampling pump not sought)	10/22/84 5/20/85 8/18/86	QA document Work Plans (Section 5.0) Pump Specifications (Attached)	None	State and county review and approval of pump construction specifications attached. The submersible pumps which Kennecott uses in sampling for SO_4, pH, metals (etc., non-organics) do not impact the analytical results. This was previously agreed to in the work plan and discussed at several Technical Group meetings.
Item 2 (Water level data and volumes purged)	8/18/86	Work Plan (Sections 5.1, 5.2)	None	Depth to water has been measured prior to well sampling and is included on the field data sheets. Field technicians pump 3 to 5 well volumes prior to each sample. Field technicians record this information on the field data sheets.
Item 3 (Decontamination of pumps and hoses and no report of transfer blanks)	8/18/86	Work Plan (Section 5.2)	None	None. The pumps and hoses have been flushed with waters of drinking water quality and pH and conductivity measurements taken to stabilization (pH ~ 7 and 1000 umhos/cm). Transfer blanks will be taken periodically.
Item 6 (Chain of custody documents not in the report)	8/18/86	Work Plan (Sections 6.1, 6.2)	None	None. The laboratory's chain-of-custody control is internal to the lab. These documents are on file at the Kennecott lab. Due to the volume, it is advised they not be included in the report. The Technical Group members are welcome to view these records and any other procedures at Kennecott's laboratory facilities.

JOINT KENNECOTT HYDROGEOLOGIC STUDY PLAN, QA/QC VARIANCES

Variance	Date(s) Discussed with Technical Group	Backup Document	Impact on QA/QC	Recommended Action (If Required)
Section 5.0				
Item 4 (Incomplete field water quality sheets)	-	-	None.	The importance of accurate and complete field data sheets is recognized, and the use of one field sheet for several sampling periods can be very beneficial in terms of comparison of previous field test results.
Item 5 (Blanks and duplicates not identified)	-	Report IV	None.	The laboratory, as part of its QA/QC, runs blanks and duplicates. Report IV includes some of this data. The laboratory keeps the records on file. The laboratory should be provided with a list of duplicates from the field program on a more routine basis. The Technical Group members are welcome to view these records and any other procedures at Kennecott's laboratory facilities.
Item 7 (Field instrument calibration not indicated on sheets)	10/86	Work Plan (Section 7.0)	None.	All meters are checked and calibrated in the field and at Kennecott's field laboratory, before they are used in the field. PH meters are calibrated prior to each sampling with pH 7 and pH 4 buffers. Conductivity meters, which do not require frequent calibration, are checked with distilled water and solution of known conductivity. Field technicians have been reminded to record instrument identification numbers on all the field sheets.

JOINT KENNECOTT HYDROGEOLOGIC STUDY PLAN, QA/QC VARIANCES

Variance	Date(s) Discussed with Technical Group	Backup Document	Impact on QA/QC	Recommended Action (If Required)
Section 6.0				
Items 1 and 2 (Documentation of buffers, standards, reagents, containers not completed nor has chain of custody)	10/86	Work Plan (Section 6.1)	None.	None. The sources of buffers, standards, reagents, sample containers etc. are from Fisher Scientific, VW&R Scientific, American Scientific Products, Industrial Container (New Sealed box). Documentation of the original source is on file with the laboratory. Similarly with the chain of custody documentation. The Technical Group members are welcome to view these records and other procedures in question at Kennecott's laboratory facilities.
Section 7.0				
Item 1 (Field instruments not identified field sheets)	-	-	None.	Kennecott's field technicians have been reminded to include this information on all the field sheets.
Item 2 (Water level measurements not completed and electric water level meters not calibrated)	-	-	None.	As per Section 5.0, item 2 variance, Kennecott's field technicians record water level data on the field sheets. Water level meters are calibrated at the beginning of the field season and/or whenever breakage to the wire or footage markers slip.

JOINT KENNECOTT HYDROGEOLOGIC STUDY PLAN, QA/QC VARIANCES

Variance	Date(s) Discussed with Technical Group	Backup Document	Impact on QA/QC	Recommended Action (If Required)
Section 9.0				
Items 1, 2, 3 (No reporting of ion balances, re-analysis or outlier identification)	-	-	None.	It has been Kennecott's standard lab practice to perform ionic balance on each sample submitted from the inception of the 5-year groundwater study program. The lab's computer program was updated and improved in 1986, and utilized with each sample, to provide ionic balance and outlier screening. Outliers are investigated and corrected, if in error, prior to release of the analytical report. The Technical Group members are welcome to view these records and any other procedures at Kennecott's laboratory facilities.
Section 10.0				
Item 1 (Blind field duplicates)	-	-	None	Blind field duplicates are on record at Kennecott's lab. The frequency of collection is at the specified 1 blind per each 10 samples.
Item 2 (County sampling and documentation)	-	-	None	The county has completed some sampling for this study. Specifics as to the number of QA samples and the QA program will need to be obtained from the county. The County will be asked to submit their QA program to the Technical Group for review.

JOINT KENNECOTT HYDROGEOLOGIC STUDY PLAN, QA/QC VARIANCES/CHANGES TO THE WORK PLAN
(Additional Key Points To The State's Comments of August 31, 1987 As Defined by Kennecott)

Variance	Date(s) Discussed with Technical Group	Backup Document	Impact on QA/QC	Recommended Action (If Required)
Section 1.0				
Introduction. Update changes of Technical Group, Citizens Advisory Council, Advisory Group membership.	10/7/87	Draft Work Plan (Attached)	None. Changes in membership primarily due to members' job responsibilities changing and reassignments.	Incorporate into updated Work Plan.
Sampling sites updated.	10/7/87	Draft Work Plan (Attached)	Positive. The number of sample sites and samples have doubled and tripled since the study began (i.e. from 145 to 755).	Incorporate into updated Work Plan.
Section 2.0				
Project Description: Objectives and Work Scope.				
Update of the drilling completions and other work completed to date.	10/7/87	Draft Work Plan (Attached)	Positive. Demonstrates that additional work (i.e. surface geophysical surveys as well as additional monitor well completion) has been conducted.	Incorporate into updated Work Plan.
Aquifer tests, including pumping test, packer tests and soil testing will be conducted, as necessary, as part of the remedial action phase rather than the hydrogeologic evaluation phase.	10/7/87	Draft Work Plan (Attached)	None.	Implement, as needed, in the remedial action phase. There is adequate aquifer test data for model completion, such that a few additional data points would not be significant in calibrating the large-scale contaminant flow model.

JOINT KENNECOTT HYDROGEOLOGIC STUDY PLAN, QA/QC VARIANCES/CHANGES TO THE WORK PLAN
(Additional Key Points Defined by Kennecott)

Variance	Date(s) Discussed with Technical Group	Backup Document	Impact on QA/QC	Recommended Action (If Required)
Section 2.0 Continued				
Slug tests should be changed to specific capacity tests which are more meaningful and can be conducted during sampling.	10/7/87	Reference USGS, WRIR, 1987, 86-4170 (Attached) Draft Work Plan (Attached)	Positive.	Approval so that specific capacity testing can begin immediately.
Well completions and locations updated for Phase I and II wells and sample sites currently being monitored updated.	10/7/87	Draft Work Plan (Attached)	Positive.	Incorporate into updated Work Plan.
Section 3.0				
Project organization updated.	10/7/87	Draft Work Plan (Attached)	None.	Incorporate into updated Work Plan.
Section 5.0				
5.1 Updated.	10/7/87	Draft Work Plan (Attached)	None.	Incorporate into updated Work Plan.
Table 1.				
List of current Technical, Advisory and Citizen's Group Members.	10/7/87	Draft Work Plan (Attached)	None.	Incorporate into updated Work Plan
Figure 2				
Updated site location map.	10/7/87	Draft Work Plan (Attached)	Positive. There are more monitor wells than originally planned and in strategic locations.	Incorporate into updated Work Plan.

Kennecott
10 East South Temple
P.O. Box 11248
Salt Lake City, Utah 84147
(801) 322-8261

Gregory H. Boyce
Director Environmental Affairs

October 7, 1987

Kennecott

Mr. Kenneth L. Alkema
Director
Utah Division of Environmental Health
State Division of Health
P. O. Box 16690
Salt Lake City, Utah 84116-0690

Dear Mr. Alkema:

This letter and attachments are in response to your August 31, 1987 letter which lists the variances from the original joint Kennecott Hydrogeologic Study Plan, Quality Assurance/Quality Control (May 20, 1985).

Kennecott is in agreement with your statement that such variations should be documented in the study reports and corrected where appropriate.

To justify and verify the project variances, we have attached a matrix table which lists the study work variances, which the State has addressed as well as variances Kennecott recognizes, the date(s) at which a variation was discussed with the Technical Group, the back-up document, the impact on Quality Assurance/Quality Control and the recommended action, if warranted.

It is important to note that the original (May 20, 1985) study plan had been revised once and formally submitted for review and was approved as Appendix I of the Third Annual Groundwater Report (August, 1986).

Since additional changes have occurred subsequent to the August, 1986 study plan, Kennecott has again revised the study plan to include these changes. A draft revised study plan is attached for your review and approval.

We believe that it is of extreme importance that this revised Agreement be approved by the Division of Health, Salt Lake City-County Health Department, and Kennecott.

If you have any questions on the attached table and draft study plan, please do not hesitate to contact me.

Sincerely,

Gregory H Boyce

Gregory H. Boyce

/mf
Attachments
Distribution: Page Two

cc: MQS
PWM
D/C 9/11/87

Norman H. Bangerter
Governor

Suzanne Dandoy, M.D., M.P.H.
Executive Director

BSHW-4557-1

RECEIVED
SEP 9 1987
G. H. BOYCE

August 31, 1987

Mr. Greg Boyce
Kennecott
10 East South Temple
Salt Lake City, Utah 84133

Dear Mr. Boyce:

Listed below are deviations from the Joint Kennecott Hydrogeologic Study Plan, Quality Assurance/Quality Control (May 20, 1985), which have been identified by our staff. Deviations such as these should be reported in each year's study report and corrected where appropriate.

Section 4.0

1. Carbonate and bicarbonate has not always been measured in the field. When this data is missing anion/cation balances cannot be performed.

2. Field/corrected specific conductance data is missing for some wells.

3. Results of routine laboratory QC checks for acceptance criteria (i.e. two standard deviations of precision and accuracy data) has not been reported.

4. Analytical results for parameters listed in Table 4.1 have not been reported for all analyses.

Section 5.0

1. State approval of submersible sampling pump has not been sought.

2. Depth to water table has not been measured or reported for most wells prior to sampling. The number of well volumes purged has not been measured or reported.

3. No information has been reported regarding decontamination of sampling pumps or hoses. Transfer blank analyses have not been reported.

Kenneth L. Alkema, Director • Division of Environmental Health
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4. Field Water Quality Data sheets have not been completely filled out. Often times the notes made on the sheets are from different sampling excursions and cannot be identified as to which sampling they pertain.

5. Blank and duplicate samples and the sample set to which they belong have not been identified.

6. Chain-of-custody documents are not included in the report.

7. Calibration of field instruments is not noted on sample data sheets.

<u>Section 6.0</u>

1. Pertinent field measurements and observations have not been recorded. Documentation of the sources of buffers, standards, reagents and sample containers has not been noted.

2. Chain-of-custody information has not been reported.

<u>Section 7.0</u>

1. Field instruments have not been identified on the field sample sheets.

2. Water level measurements have not been made. Calibration of electric water level meters has not been performed.

<u>Section 9.0</u>

1. The laboratory has not reported ion balance results.

2. Ordered reanalyses (corrective actions) have not been reported.

3. Outliers have not been identified in laboratory reports.

<u>Section 10.0</u>

1. Results of blind field duplicate analyses have not been identified (if reported).

2. County sample splitting has not been performed. A county QA document has never been submitted to the State.

Additional comments regarding QA/QC have been furnished for each year's Annual Report. These comments should be reviewed for applicability.

If you have any questions regarding this correspondence please contact Mr. Joel Hebdon of my staff at 538-6170.

Sincerely,

Kenneth L. Alkema

Kenneth L. Alkema, Director
Utah Division of Environmental Health

KA/JH/psw

Distribution:

With Attachments

J. B. Winter
P. W. McCallum
M. Q. Spencer
Dames & Moore
Steve McNeal
Terry Sadler